REPRESENTING THE HIGH TEMPERATURE INSULATION WOOL INDUSTRY
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Environmental Emissions

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Focus on alumina-silicate wool (ASW/RCF) Manufacturing Facilities

Introduction

Alumino-silicate wools (ASW) (also termed Refractory Ceramic Fibres [RCF]) belong to the group of Man Made Mineral fibres (MMMF)[1] and further included in the sub-group of High Temperature Insulation Wools[2] (HTIW). Given the classification for ASW/RCF in Europe as a category 1B carcinogen[3] under CLP (EC) 1272/2008, it is important to investigate and quantify the impacts of air emissions from ASW/RCF manufacturing facilities onto the local environment. Accordingly ASW producers conducted a series of studies over the years to measure particulate and fibre emissions and "fence boundary" fibre concentrations as part of their ongoing product stewardship program (PSP).

The intention of the emissions studies was to develop the data necessary to characterize emissions and resulting fibre and particulate concentrations and, if necessary, to make changes in control technology to reduce possible impacts.

The results of these studies should allay possible concerns related to public health impacts and demonstrate that general assumptions on environmental exposure pathways are overestimated, at least for these materials. This document reviews all available data within Europe and the USA, relating to stack emissions, air dispersion modelling, and fence line measurements (at key positions around such facilities). Consideration was given to results obtained from manufacturing sites located in:

- Europe (France, Germany, and the UK)
- North America (USA and Canada)

An additional study on ASW fibre concentrations associated with disposal of ASW/RCF materials at a landfill was conducted in the USA.

Stack Emissions in Europe

Within Europe, amorphous High Temperature Insulation Wool (HTIW) manufacturing facilities are required to comply with the Industrial Emission Directive 2010/75/EU (IED). The Best Available Techniques (BAT) reference documents (termed BREFs) were adopted under both the IPPC Directive (2008/1/EC) and the IED. The "BAT conclusions" define what are termed "best available techniques" (BAT) for emissions

[1] Also termed synthetic vitreous fibres (SVF).
[2] EN 1094-1 Insulating refractory products - Terminology, classification and methods of test for high temperature insulation wool products; 2008
[2] First classified in 1997 under EC 67/548 as category 2 carcinogen and this was automatically transposed into CLP (EC1272/2008).
[3] Best Available Techniques (BAT) Reference Document for the Manufacture of Glass Industrial Emissions Directive 2010/75/EU (Integrated Pollution Prevention and Control)

control. According to Article 14(3) of the IED, BAT conclusions are the reference for setting the permit conditions to installations covered by the Directive. The BAT conclusions address the industrial activities specified in Annex I to Directive 2010/75/EU, and for ASW/RCF manufacturing. These are applicable to facilities that produce:

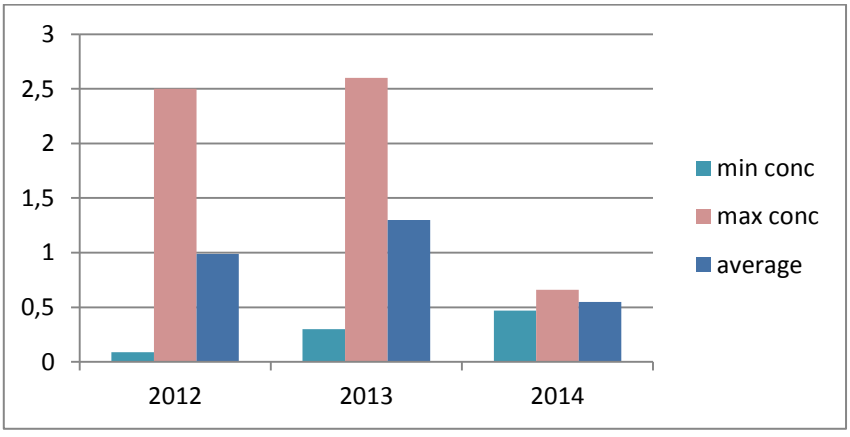
- 3.3. Manufacture of glass including glass fibre with a melting capacity exceeding 20 tonnes per day;
- 3.4. Melting mineral substances including the production of mineral fibres with a melting capacity exceeding 20 tonnes per day.

In the case of HTIW, typical production volumes at manufacturing facilities range between 5 and 10 tonnes/day. Therefore, these volumes are below the tonnage specification of 20 tonnes/day set by the Directive. However, the industry fully supports the objectives of the BREF and for that reason it is included in the GLS BREF.

As an example of adopting BAT technology, manufacturers operate the waste gas treatment systems during normal operating conditions at optimal capacity and availability in order to prevent or reduce fibre and particulate emissions. All particulate emissions from the European manufacturing processes are controlled using high efficiency dust collection systems prior to exhaust to the associated stacks. All control systems are running throughout operational periods and are routinely inspected.

All such manufacturing facilities conduct annual stack emissions testing to demonstrate compliance and to introduce Best Available Techniques (BAT) to maintain compliance with the current stack emissions level of 1- 5 mg/m,^{3} which covers all glass wool and manmade mineral wool facilities. ASW/RCF emissions for downstream processes need to be compliant with the lower limit of 1 mg/m^3- note that gravimetric units are used for BAT compliance testing while fibre measurements are usually reported as fibres per millilitre (f/ml) in the studies discussed below.

The figure below is an example of ASW/RCF particulate (including fibrous dust) stack emissions from European plants for the last 3 years.



Manufacturers are generally in compliance with BAT and stack emissions are typically < 1 mg/m^3 for downstream activities.

Dispersion Modelling

Dispersion modelling has been used in the UK to assess the impact of emissions on the environment by calculating the predicted ground level concentrations arising from the emissions to atmosphere, based on Gaussian approximation techniques. The worst-case concentrations were then compared with applicable air quality standards to determine whether releases from the installation were likely to cause a significant impact on the receiving environment.

The particulate emissions in the UK facility were consistently below the benchmark level of 5 mg/m^3 following the introduction of bag filter abatement equipment as noted in the BAT requirements above.

The model employed in the UK was the new generation model ADMS3[4], which was developed by Cambridge Environmental Research Consultants (CERC) for UK regulatory use.

Fence Boundary Measurements Europe

Over the period from 2004 to 2009 European manufacturers collected fence-line measurements to evaluate concentrations of ASW/RCF fibrous dust in air in the vicinity of manufacturing facilities. Analysis of the resultant filters was conducted using scanning electron microscopy (SEM) to assess the WHO fibre concentrations. Specifically:

- RATH GmbH sponsored a study of fence boundary concentrations in the immediate vicinity of its Mönchengladbach, Germany plant[5]. The upper 95% confidence limits on measured ASW/RCF (WHO fibre) concentrations at several sampling locations (four wind directions) ranged from approximately 0.0004 to 0.0012 fibres per millilitre (f/ml).

[4] The model was approved for this type of assessment by the Environment agency and is distinguished by a more complex modelling scheme:

> "ADMS3 uses a continuous calculation method to determine the conditions of the receiving atmosphere based on the Monin-Obukhov length, which represents the height of the boundary layer and the degree of turbulence within the atmosphere. This is generally regarded as a more comprehensive modelling approach than that employed by older models such as ISC, which use discrete approximations to the atmospheric conditions known as Pasquill stability classes."

This statement has been made about this model in several environmental impact statements (e.g., http://sse.com/media/227466/SSE-Seabank3-PEI-Vol-I-Report.pdf and http://multifuelenergy.com/wp-content/uploads/2013/05/11d-Appendix-11A-Air-Quality-Assessment-Technical-Appendix.pdf).

[5] Bericht Immissionsmessungen Messung der Faserzahlkonzentration in der Außenluft. Werksgrenzen und Umfeld der Finma RATH GmbH. Gesellschaft für Schadstoffmessung und Aufstragsanalytik GmbH (GSA), 2004. GSA analytical report, October 27, 2004. 9 pp.

- Unifrax commissioned fence boundary studies of its plants in Lorette[6] and Ambert[7], France. Monitoring results indicated that fibre concentrations at these two locations were generally at or below detection limits. Fence line measurements of fibre concentrations from 2010 up to 2015 ranged from 0.0001 to 0.005 f/ml).
- Morgan Technical Ceramics also commissioned a study of fence boundary concentrations in the immediate vicinity of its Saint Macellin en Forez plant in France.[8] The measured Alumino-silicate fibre concentrations at several sampling locations ranged from approximately 0.00009 to 0.00098 f/ml.

Stack Emissions in USA and Canada

From 1990 through 1992 the ASW/RCF industry in the United States conducted a cooperative program with the United States Environmental Protection Agency (USEPA) to measure ASW/RCF dust emissions and fence boundary concentrations in the vicinity of ASW/RCF manufacturing plants and a landfill where ASW/RCF were disposed.[9] Eight ASW/RCF manufacturing and processing facilities were included in the programme. The annual emission from the ASW/RCF processes were well below the threshold for a major source as defined in the Clean Air Act (CAA). This study concluded that ASW/RCF emissions were *de minimis,* with most of the measurements being below the limit of detection for the methodology used. Ambient fibre concentrations in the vicinity of ASW/RCF manufacturing were frequently below the limit of detection and (among concentrations above the limits of detection) ranged from 0.002 to 0.003 f/ml (a factor of 167-250 below the present Recommended Exposure Limit (REL) of 0.5 f/ml[10]). Based in part on this study, USEPA concluded that ASW/RCF exposure might be a potential workplace issue, but not a public health hazard and referred the matter to the Occupational Safety and Health Administration (OSHA).

Monitoring of stack emissions and fence boundary ASW/RCF concentrations was also conducted in Canada under a cooperative program with the Canadian government.

[6] Rapport D'essai: Mesures de rejets atmospheriques, Apave, 2006. Unifrax, Lambert. Report by Yves Rouillon, May 16, 2006. 51 pp.

[7] Report D'Analyse, MOCP, Unifrax, Lorette. Ascal, 2009. Doc 09/03/rapport MOCP /001. 2 pp.

[8] Determination of fibre number and fibre concentration by scanning electron microscopy (SEM) according the guideline VDI 3492. Site: Saint Marcellin en Forez, Sample Date: 6/10/2005. Gesellschaft für Schadstoffmessung und Aufstragsanalytik GmbH (GSA), 2005. GSA analytical report, Reference number: 021105-1.Kd ECFIA.doc.

[9] Refractory Ceramic Fiber (RCF) Emissions from Domestic Production Facilities and Related Matters; Phase 1 Final Report. *Everest Consulting Associates* (ECA), 1992. Prepared for *Office of Toxic Substances* (OTS), Office of Pesticides and Toxic Substances, U.S. *Environmental Protection Agency* (EPA) Washington, DC. Prepared on behalf of TIMA, Inc. and TIMA Member Companies. Prepared by W. J. Breitsman, L. D. Maxim, J. Allshouse, O. Crankshaw, and C. Wrenn. 20, April, 1992.

[10] The REL was set by the National Institute of Occupational Safety and Health (NIOSH); NIOSH Publication No. 2006–123, Criteria for a Recommended Standard Occupational Exposure to Refractory Ceramic Fibers. NIOSH, 2006, Atlanta GA, 224 pp. This level is numerically equal to the industry's recommended exposure guideline (REG) in the US. Occupational exposure limits vary by country.

This effort showed that fence boundary concentrations were "very low to undetectable." In fact, according to the Canadian Government:

> "Environment Canada and Health Canada reviewed the monitoring results and confirmed that there is negligible health risk for the general public associated with RCF emissions from these plants, and that no further stack sampling was necessary."[11]

Other published data

Two other studies provide potentially relevant European data for non-occupational exposure to ASW/RCF:

- Schneider *et al.* (1996)[12] measured concentrations of various types of fibres in Denmark, France, and Germany. They reported arithmetic mean concentrations of (all) inorganic fibres (WHO fibres > 5 µm in length) ranging from 0.004 to 0.008 f/ml for groups of schoolchildren, retired persons, office workers, and taxi drivers of which less than one quarter were synthetic vitreous fibres. GSA evaluated the fibres in the Schneider *et.al.* study by analysing the same samples for ASW/RCF fibres. Alumino-silicate fibres were only a fraction of the concentrations found in the Schneider samples and it was determined that it was ubiquitous alumina-silicate particles but not "man-made ASW/RCF" with parallel edges.[13]
- A complete review of exposure to asbestos and MMMF in buildings, (*Fibrous materials in the environment*), was published in 1997 by the Institute for Environment and Health (IEH)[14] IEH concluded that environmental levels of MMMF are generally less than 0.00005 f/ml, but in buildings with MMMF insulation, fibre levels can be up to 0.001 f/ml. MMMW Fibre (mineral- and glass wool) levels generated during home improvement and maintenance activities can be up to 0.2 f/ml. ASW/RCF is not used for home insulation products.

Summary

Data from Canada, Europe, and the United States indicate that there is very little potential for general public exposure to RCF. RCF is an industrial, not a consumer product, and available data indicate that concentrations close to producer plant boundaries and landfills are not detectable or very low.

[11] Completed Agreements, Refractory Ceramic Fibre Industry. Environment Canada, 2013. Available online at: http://www.environment-canada.ca/epe-epa/default.asp?lang=En&n=781A5AFB-1.
[12] Ubiquitous fiber exposure in selected sampling sites in Europe; Thomas Schneider M SC, *Work Environ Health* 1996; 22:27.
[13] Untersuchung über Al-Si-Fasern in EURIMA Proben; GSA Kunzendorf; Teicher- 2004 .
[14] Institute for Environment and Health, Leicester, ISBN 1 899110 17 8.